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Nitrogen use efficiency and energy harvest in wheat, maize and grassland ley used for biofuel – implications for sustainability

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Abstract

One of the most important resources within agriculture is nitrogen (N), and depletion of N resources is an important element in the evaluation of sustainability in agriculture. Therefore, identifying crops with high nitrogen use efficiency (NUE) is important for the sustainability of the system. In an energy crop context, sustainability in crop production could aim at enhanced energy output with maintained or reduced depletion of N resources. Crops with different photosynthetic pathways (C_3 vs. C_4) and life histories (perennials vs. annuals) are expected to differ in NUE and also energy harvest per unit N lost from the system.

The aim is to characterize the growth, NUE and energy output per unit N lost for three common crops frequently used for energy; maize, winter wheat and perennial grassland (ley). These crops differ in photosynthetic and life history strategies.

Above ground biomass of wheat, grassland ley and maize was sampled within a long-term experiment in Central Sweden. The experiment has a split-plot design with four replicates. Four aboveground harvests were conducted during the growth period and plant N contents were determined. Biomass growth, yield (above ground biomass in ley and maize, grain biomass in

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wheat) and some functional traits were assessed, and the NUE components N uptake efficiency, yield-specific N efficiency and yield N concentration were calculated according to Weih, et al. (2011). Energy output per N lost with the harvested product was calculated assuming crop-specific higher heating values for biofuel use.

The N uptake efficiency and yield-specific N efficiency were higher in maize than wheat and ley. The yield N concentration was higher in the perennial ley than the annual crops, and lowest in maize. Energy output per N lost in the harvested product was greater in maize compared to wheat and ley. The results are discussed in a agricultural sustainability perspective.

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Keywords: nitrogen use efficiency; energy production; sustainability; wheat; maize; perennial grassland

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